AVOIDING STIFFNESS: PERSPECTIVES OF AGILE TECHNOLOGY DIFFUSION

Volkan Ezcan [1*], Jack Steven Goulding [2], Farzad Pour Rahimian [2], and Murat Kuruoglu [1]

[1] Construction Management Division, Civil Engineering Faculty, Istanbul Technical University, Ayazaga, Istanbul, 34469, Turkey; Email: ezcan@itu.edu.tr
[2] The Grenfell-Baines School of Architecture, Construction and Environment, University of Central Lancashire, Preston, PR1 2HE, UK
[*] Corresponding author (ezcan@itu.edu.tr)

ABSTRACT

The increased pervasiveness of Information and Communication Technology (ICT) within the Architecture Engineering and Construction (AEC) sector, not only introduces unparalleled opportunities for enhancing the performance of design/engineering/construction processes per se, but also serves as a unique lever for improving and delivering overall competitiveness. However, whilst the onset and evolution of ICT keeps improving, it is also recognised that organisations often fail to match this evolution, most notably through the adoption, diffusion and dissemination of this technology. This has also been acknowledged as a barrier, particularly concerning innovation opportunities. Cognisant of this, organisations are increasingly looking to secure full advantage of emerging ICT developments. On this theme, this study identifies a series of priority areas for organisations, with the specific remit of securing agility (in the market) through ICT diffusion. A questionnaire, based on an Agile-Technology Diffusion framework, was used to capture the perceptions of management professionals working in the Turkish AEC sector. The ranking analysis of the survey results and comparison of the different management perceptions (levels) are presented for discussion. Research findings identify several priority areas that need to be addressed. These findings also uncover significant differences in the perceptions of different management levels - which can help decision makers appreciate the holistic interdependencies, especially the factors which impinge (or impede) overall competitiveness.

Keywords: *Productivity and Workforce Issues, Agile-Technology Diffusion, ICT, AEC, Turkey.*

1. INTRODUCTION

The AEC sector has a significant impact on global economies. However, is has not evolved at the same rate or pace as other industries, including aerospace, manufacturing etc. The causal effects of this have been attributed to a number of issues, not least “one of a kind products”, or “low reliability” – see for example, Fernández-Solís (2008) on solutions developed for manufacturing industry and construction. Notwithstanding this debate, there is a need to create bespoke solutions for the development of different patterns in order to describe the nature of innovation in construction (Aouad et al., 2010). Innovation has been defined by a number of authors, one example of which is “the successful development and/or implementation of new ideas, products, processes or practices in order to increase organisational efficiency and performance” (Akintoye et al., 2012); and ICT has been presented as a major driver in this respect (e.g., Egan, 1998; Latham, 1994), to act as an enabler for innovation (Aouad et al., 2010). In essence, ICT can be seen as a strategic tool to deliver innovation and improve overall competitiveness. Therefore, the adoption and diffusion processes of ICT within organisations need carefully managing; particularly the need to overcome ‘stiffness’ in order to embed novel technologies (Chen et al., 2014). Acknowledging this, this study investigated the ICT diffusion process in the Turkish construction sector, to identify ‘blockers’ and ‘enablers’ from an agility perspective. Rogers (2010) defined “diffusion” as a conduit for communicating innovation over time among the members of a social system. The key point to be considered here is that diffusion is considered as a ‘process’, comprising of five main stages: Knowledge, Persuasion, Decision of Adoption, Implementation and Confirmation. The decision for adaptation is usually authorised by senior management; yet a key element of this is users’ engagement and acceptance. Therefore, the elements that affect and shape individuals’ intentions to use new technology is important (Venkatesh and Davis, 2000). Technology diffusion is a complex process that is affected by several issues, not least: intra-personal (motivation, voluntariness to use etc.), interpersonal (trust, communication etc.), organisational (power, structure, etc.) and environmental (dynamism, competition, etc.) levels dynamics (Hameed et al., 2012).

2. AGILITY IN TECHNOLOGY DIFFUSION

Concurring with myriad of preceding studies, Zhang and Sharifi (2000) defined the term ‘agility’ as an ability that enables organisations to respond quickly and effectively to the unpredictable (but continuous) changes in order to thrive in a competitive environment. In essence, agility has widely been recognised as one of the most important

dynamic resources and capabilities of an organisation to achieve competitive advantage in the dynamic markets that feature risks and uncertainties (Helfat et al., 2009). However, Sherehiy et al. (2007) asserted that this is more important to understand the ways that the organisations can gain the capacity of agility than focusing on what this capacity can bring to these organisations. In accordance to this, various frameworks have been developed to enlighten the nature of agile systems of manufacturing, enterprises, workforces. Consequent to the positive impacts of ICT on businesses, Dunlop-Hinkler et al. (2011) introduced a new characteristic so called "technology agility" which urges organisations to develop their abilities in showing quick responses to technological changes. This impact on business increases in direct proportion to the diffusion level of the ICT in an organisation which was introduced by (Hall and Khan, 2003). The blend of these two approaches leads organisations to the fact that they should not only develop their skills to diffuse novel technologies, but also be capable of doing it agilely, in order to survive in the market, which has an increasing dynamism and competitiveness. In other words the organisations should be responsive to new technologies, flexible in terms of resources, and competent to manage the process.

In their conceptual framework of Agile Manufacturing, Sharifi and Zhang (1999) defined responsiveness as "the ability to identify changes and respond quickly to them, reactively or proactively, and to recover from them". In order to be responsive, AEC organisations should possess three basic capabilities. First of all, organisations should be able to (R1) sense, perceive and anticipate changes and risks in the environment (Malik, 2013). They should also be aware of emerging technologies, their possible impact on the organisation and the market dynamics. After sensing and being aware of the changing environment, organisations should be capable of (R2) showing immediate reaction to change and its demands (Holweg, 2005). This reaction means going out of the standard process and it brings the (R3) need of recovery (Stuart, 1996), which is the last capability that is needed to be responsive.

Flexibility of an organisation can be defined as "the capability to make changes and the capacity to control to achieve best fit towards business needs with little consumption of resources and disturbance on performance" (Ni, 2007). This change and control can be on (F1) Human Resources (Bhattacharya et al., 2005), (F2) IT Infrastructure (Masrek and Jusoff, 2009) or/and (F3) Processes (Narasipuram et al., 2008) in order to give the optimum response to change requirements. Besides being responsive and flexible, the organisation should also be competent to manage the process, which Sharifi and Zhang (1999) defined as having the "extensive set of abilities to provide a basis for productivity, efficiency, and effectiveness of a company's activities". In order to manage the process efficiently, the organisation should be capable of; (C1) developing IT, HR and training strategies aligned with business strategy (Albeladi et al., 2014); (C2) managing (Brisson-Banks, 2010) and (C3) leading (Davis and Songer, 2009) the change process.

3. METHODOLOGY

This study aimed to determine the priority areas that an organisation should focus on for providing agility in technology diffusion. Despite the adopted positivist approach, this paper reports on conducted the preliminary study aiming to understand the links and interdependencies in AEC organisations, to determine the level of existence of the agility capabilities. As such, a survey was adopted with a "close-bounded" research lens, focussing on Turkish contractors who are competitive in the international market (purposive sampling based on the list released by ENR, 2014). The questionnaire was designed following the methodological framework of Agile Diffusion parameters (Figure1).

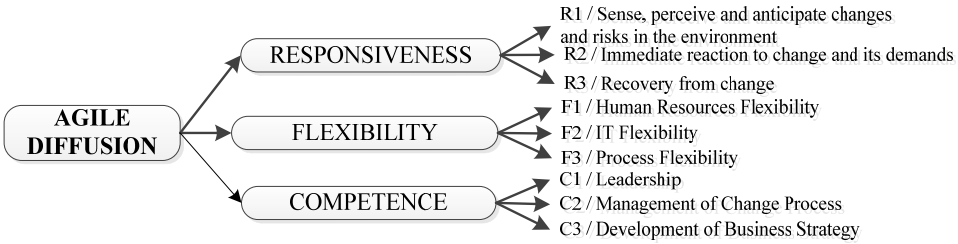

Figure 1: Agile-Diffusion Capabilities Framework

The respondents group of this survey comprised of 30 people from management levels, therefore, the survey was conducted during face-to-face sessions seeking for qualitative data. The first part of the questionnaire aimed to investigate respondents' background including: experience in AEC field (Q1), level of management (Q2) and experience in the level that he is working. The second part was however, based on the methodological framework of Agile Diffusion parameters and respondents are asked to rate the level of existence of the given criteria based on a scale of 1-5. In order to analyse the data, Relative Importance Index (Holt, 2013), which is a frequently used method to analyse response scales in Construction Management Research, is used to determine the priorities. Even though they are based on the same logic of ranking relative importance, the method has been used in different names to reflect the application, e.g. Severity Index, Relative Agreement Index. (Holt, 2013). In this regard, the

term "Relative Existence Index" is used in the study to determine the rankings, as the level of existence is questioned by the questionnaire. The following formula is used to determine the index:

$$Relative\ Existence\ Index\ (REI) = \sum_{i}^{5} \left(\frac{\omega i.fi}{a.n}\right)$$

i	= is the point given to each criterion by the respondent,
ωi	= is the weight for each point
fi	= is the frequency of the point I by all respondents
n	= is the total number of responses
a	= is the highest weight (which is 5 in this study)

4. RESULTS AND DISCUSSION

The results of the questionnaire presents the perceptions of the respondents from three different levels of management. The distribution of respondents' experience demonstrates that more than 43% of the group has been working in the industry for 16 years and more. This shows that the experience level of the group is high and it is supposed to provide a positive impact on the accuracy of their perceptions. The results of the analysis were ranked, from negative to positive existence, as the aim was to prioritise the weak points. The results show that (Table 1), the Recovery from change (REI: 0.813) is the most neglected capability. Immediate reaction to change and its demands (REI: 0.847) followed by Human resources flexibility (REI: 0.853) are the other two weak points that take place in the top three capabilities, which the organisations should focus on, in order to gain improvements in agility of technology diffusion. This ranking also shows that Turkish AEC organisations which are internationally competitive are capable in the management of change processes (REI: 0.940) which requires abilities like, process reengineering, high level of communication.

Table 1: Agile Diffusion Capability Rankings

Agile Diffusion Capability	TM		MM		FLM		**TOTAL**	
	Rank	REI	Rank	REI	Rank	REI	Rank	REI
R1 / Sense, perceive and anticipate changes and risks in the environment	4	0.933	5	0.883	2	0.817	4	0.867
R2 / Immediate reaction to change and its demands	1	0.867	2	0.850	4	0.833	2	0.847
R3 / Recovery from change	2	0.867	3	0.850	1	0.750	1	0.813
F1 / Human Resources Flexibility	3	0.900	1	0.833	6	0.850	3	0.853
F2 / IT Flexibility	7	0.967	4	0.850	8	0.917	8	0.900
F3 / Process Flexibility	5	0.933	6	0.883	7	0.883	7	0.893
C1 / Leadership	8	0.967	7	0.883	5	0.833	5	0.880
C2 / Management of Change Process	6	0.933	9	0.967	9	0.917	9	0.940
C3 / Development of Business Strategy	9	0.967	8	0.917	3	0.817	6	0.887

Notes: TM-Top Management, MM-Middle Management, FLM-First Line Management; REI-Relative Existence Index

The examination of the perceptions of different management levels declares that; the capability of showing Immediate reaction to change and its demands has the first rank for TM (REI: 0.867). Even though MM level respondents also emphasise that it is one of the most neglected capabilities (REI: 0.850), their responses state that it should take the second place after Human resources flexibility (REI: 0.833), which is ranked as the first. The perception of the respondents from FLM level match up with the responses of the whole group for the first rank, which they point out the organisation's capability to Recover from change (REI: 0.750) as the weakest. Differently from the two higher levels (TM and MM), which have not included it in the top three, FLM level believe that their organisation lacks the ability to Sense, perceive and anticipate changes and risks in the environment (2nd rank; REI: 0.817). Another perception of FLM level that contrasts with the other two is about the Development of Business Strategy (3rd rank; REI: 0.817) which is assessed as the strongest part of the organisation nearly by both levels (TM: 9th rank; REI: 0.967/MM: 8th rank; REI: 0.917). Besides the facts that are reflected by the ranking results, another point that takes attention about the analysis is the increase of the REI scores in direct proportion to the increase in the management levels, which can be interpreted as the perceptions about the organisation becomes more positive or people do not want to share negative sides of their organisation as they have upper levels in management.

5. CONCLUSION

As the impact of agility on the competitiveness has been understood day by day, manufacturing organisations focussed on developing solutions to achieve this capability and enhance their understanding of production. ICT is another core driver of improved performance in AEC industry and for that reason, the nature of technology diffusion or adoption decision in AEC organisations has been subject to numerous research, as it has been to different industries. The blend of these two concepts is the novel approach that this research presents. Adopting an approach that addresses ICT diffusion from an agility lens, this paper, presented the areas to be focussed on by the AEC organisations, which are aiming to improve their agility in technology diffusion process, based on the perceptions from different management levels. The number of respondents can be regarded as the limitations of this research. However, given that the findings presented in this paper are bounded and constrained by this sample set; some important reflections are noted vis-à-vis the general mechanisms of technology diffusion in Turkish AEC

organisations, through an agility lens. It is therefore recognised that additional work is needed to strengthen the generalisability and repeatability of this research beyond this sample set. Further work will investigate the underlying links and causal dependencies that impinge on innovation, as this is considered an important lever for improving the overall competitiveness of Turkish firms in the global market.

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